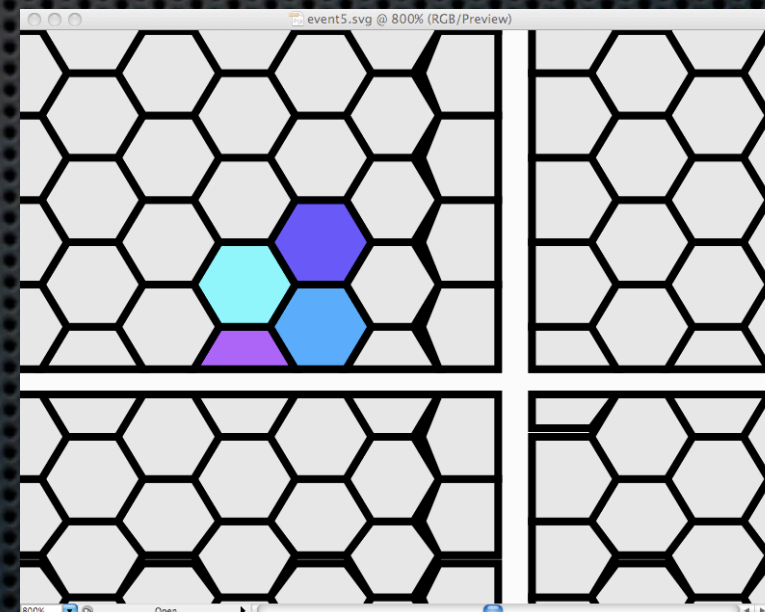# Hub n' Spoke Clustering

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Oct 14, 2008

What is Hub n' Spoke?

* A novel clustering algorithm designed specifically to identify "single" and "double" electron events in HBD.

* The hub can be defined as initial multi-pad cluster associated with track.

* The spoke is defined as neighboring multi-pad cluster which can be associated with hub.

* Combination of hub and spoke should account for majority of Cherenkov response.

Hub n' Spoke Algorithm

1. Use central arm tracks to locate hub center.

2. Generate n-tuple around hub center.

3. Search all neighboring n-tuples within given radius to find spoke with maximum charge.

4. Determine likelihood that track was "single", "double" or hadron.

Issues with old Coordinate System
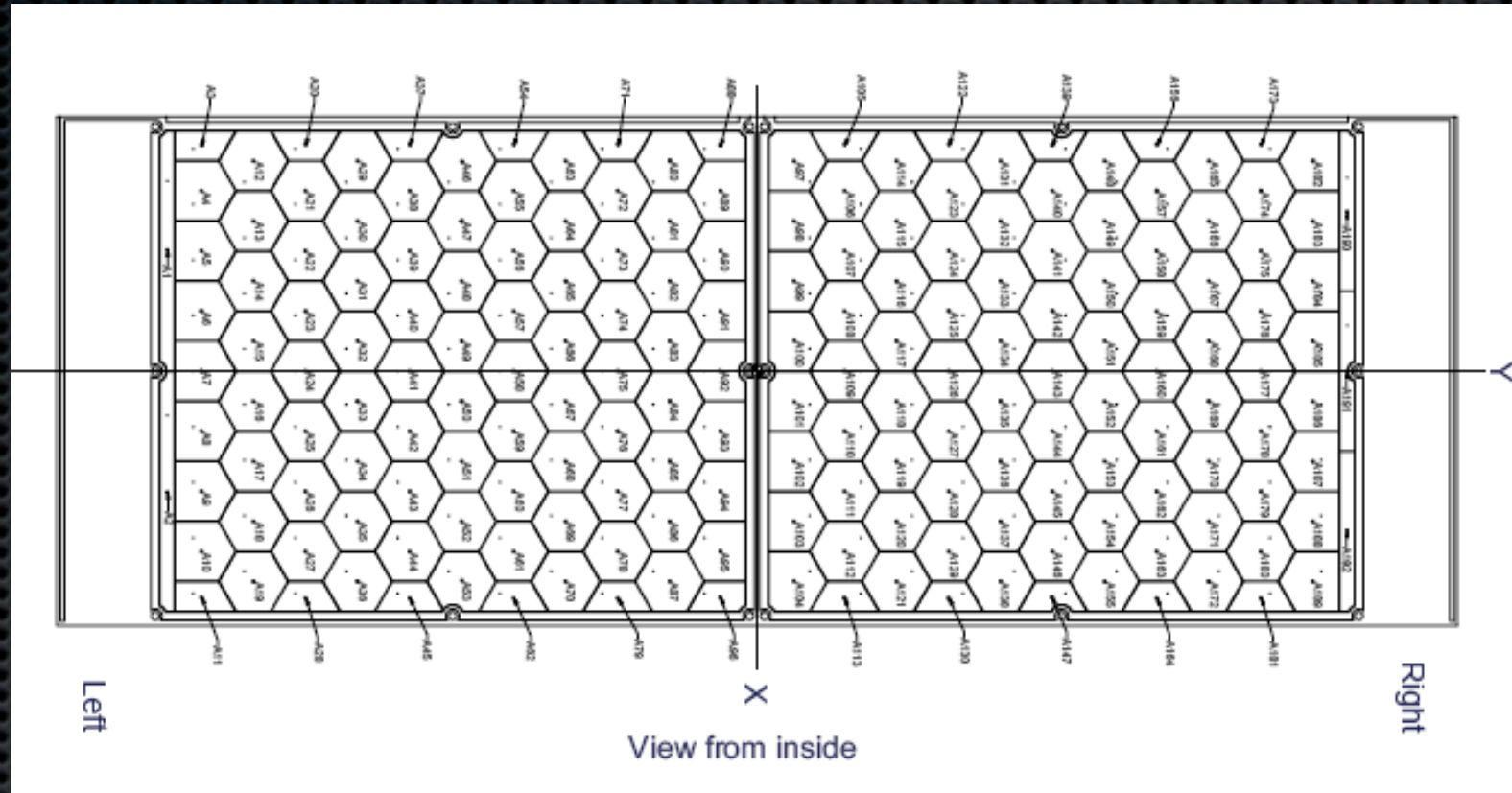
- Old clustering uses padnum, sect coordinates.

- Creates difficulties when clustering near edges.

- Roughly 10% of clusters will include edge effects.
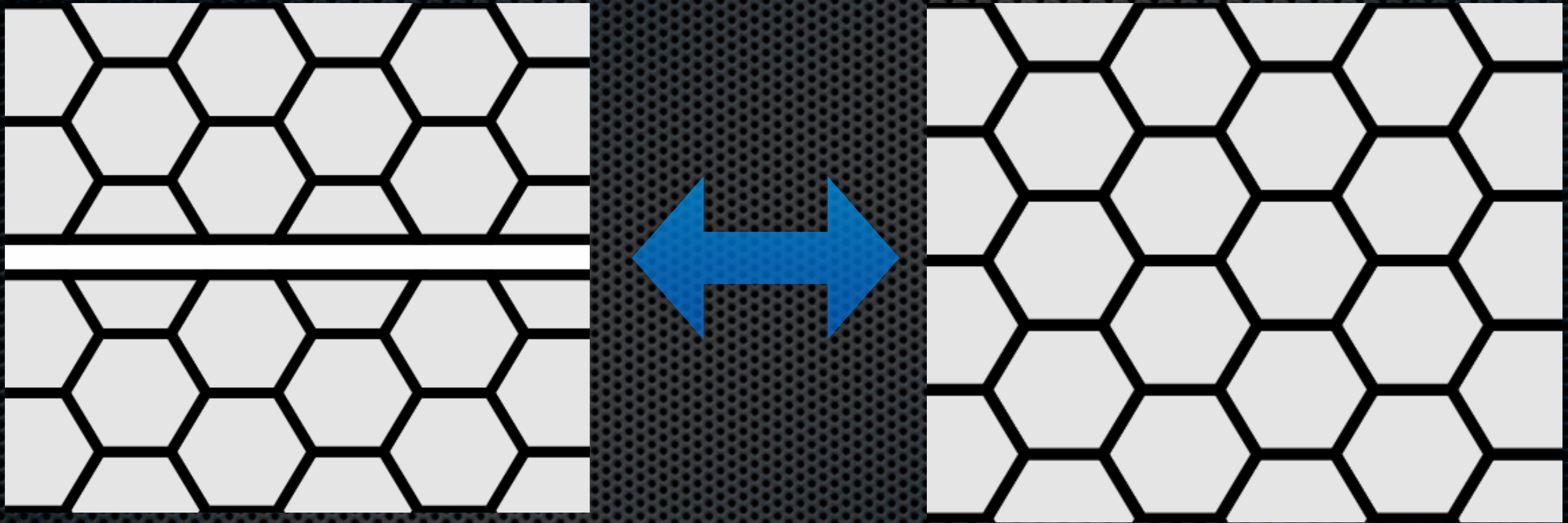
- All HbdCells defined in terms of padnum, sect, charge.

Use new Hexagonal Coordinate System

* Switch to non-orthogonal row, column coordinates.
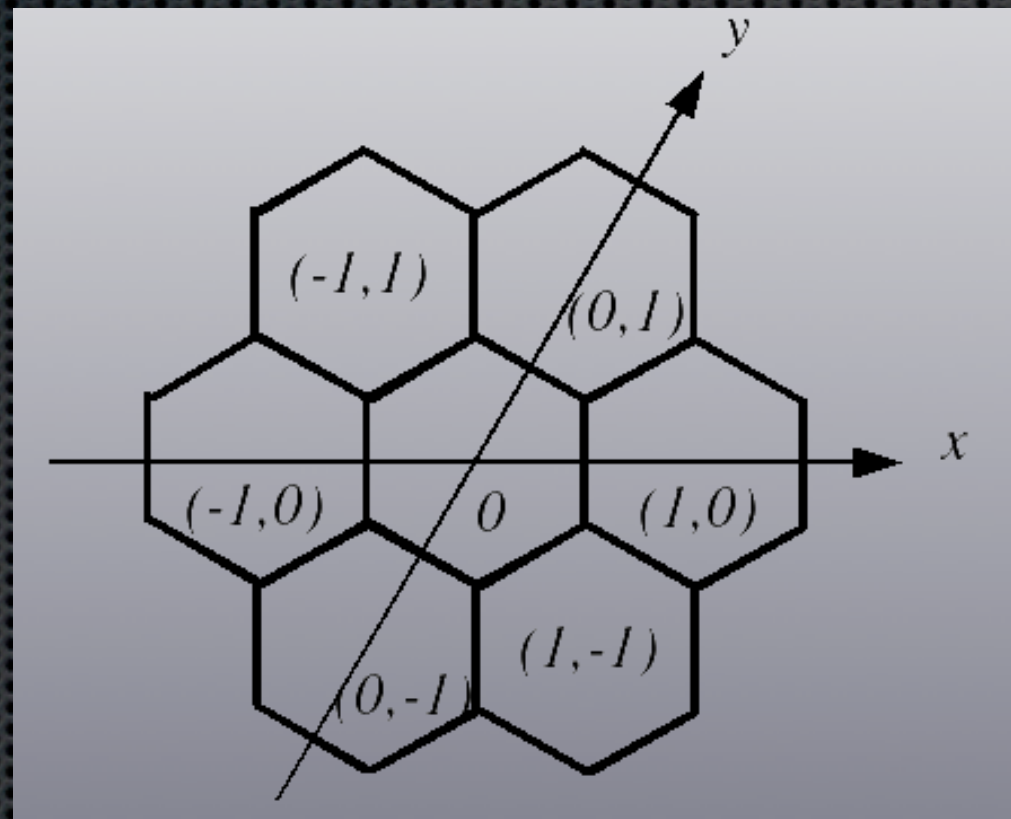
* This is the natural coordinate system for hexagonal systems.

Cell Mapping is not one-to-one

- Since edge cells are split, there will be multiple cells for given row, col coordinates.

Solve using multimap

- A multimap allows different elements to have the same key value.

- Define key as padindex for every cell with a padnum and sector.

- Code become complex ie. must first convert padnum to padindex, and then get row, col coordinates, return list of padindex for given row, col, and finally convert padindex back to padnum.

- Works but its ugly!

Cluster-Track Association

* Each track in central arm can be projected back onto HBD.

* We can cluster around this track to determine whether it is a "single", "double", or hadron.

* Currently using itrk integer as map between tracks and clusters.
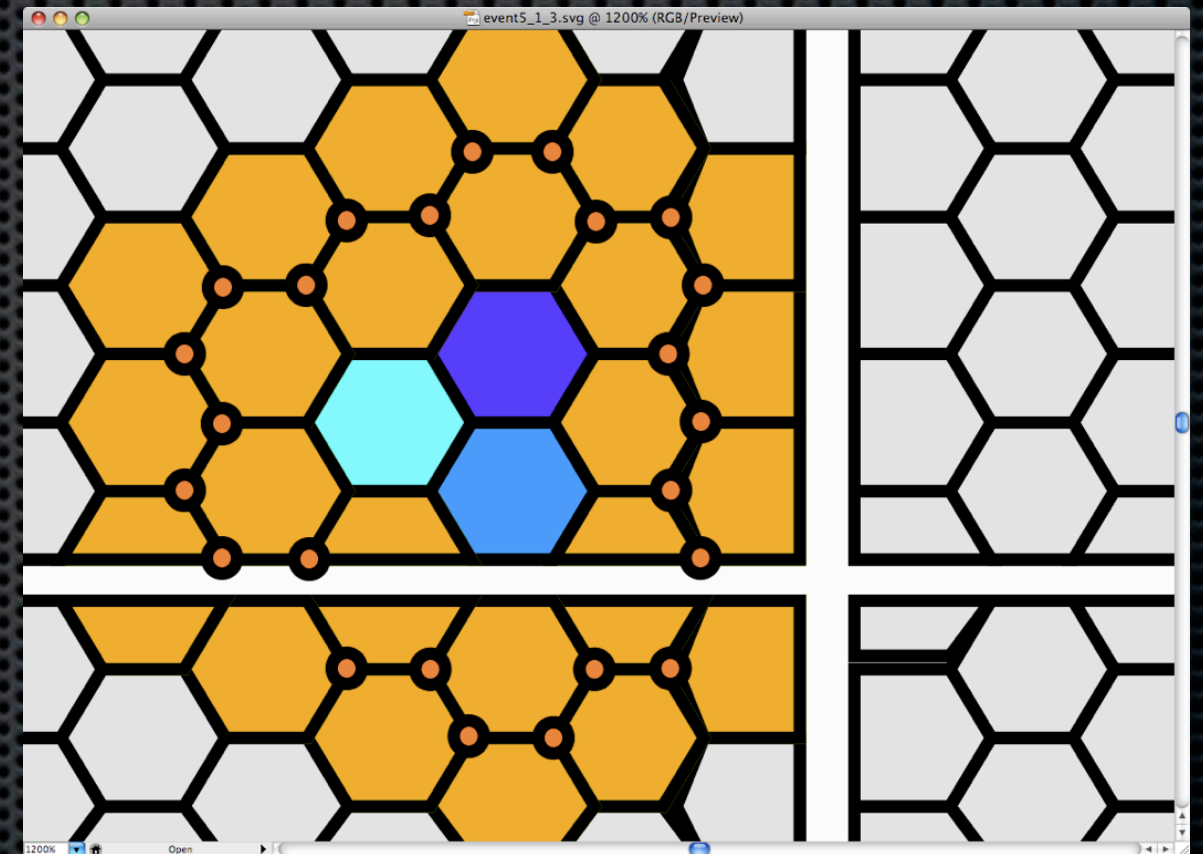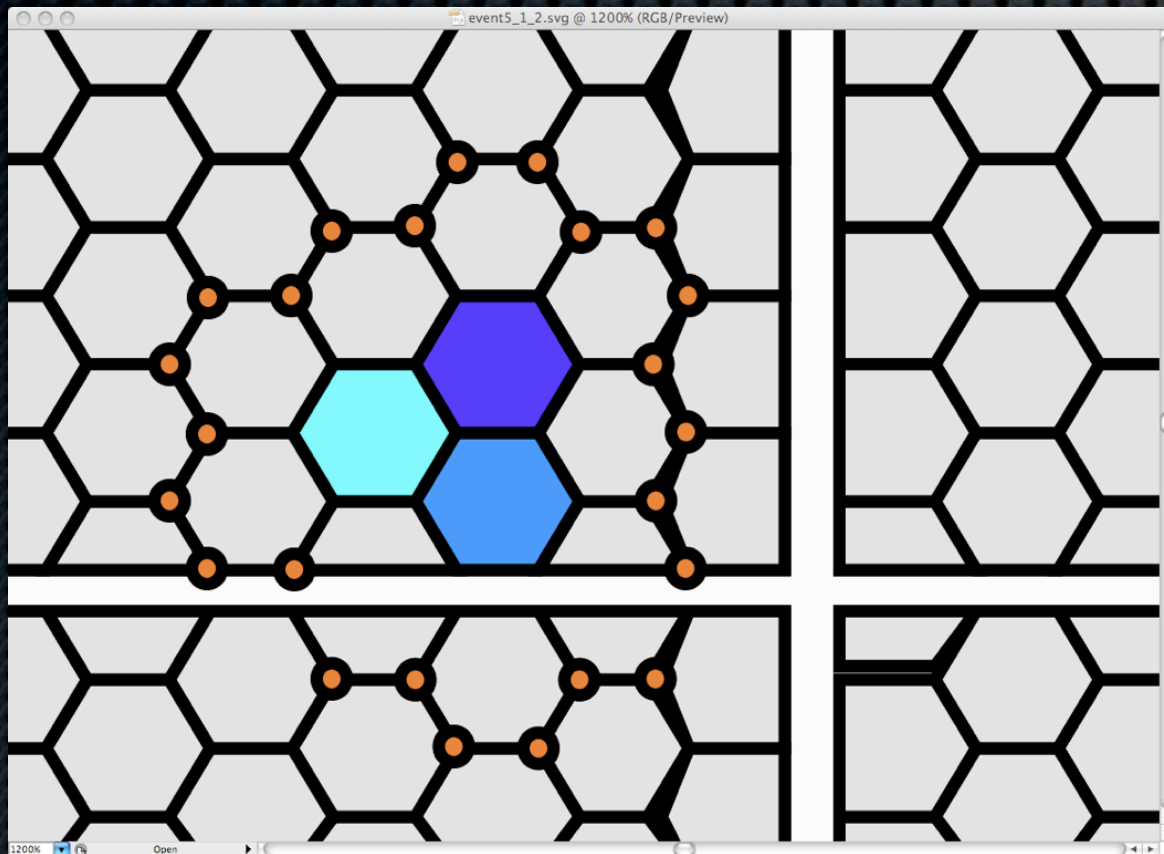
* What to do if two tracks belong to same cluster?
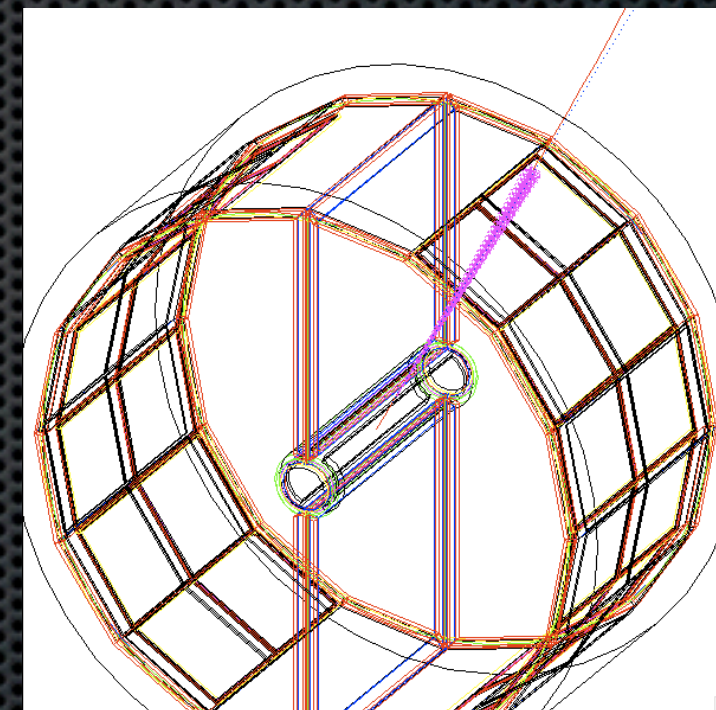
Defining initial three-tuple hub

- Given track projection in Hbd coordinates we can begin clustering algorithm.
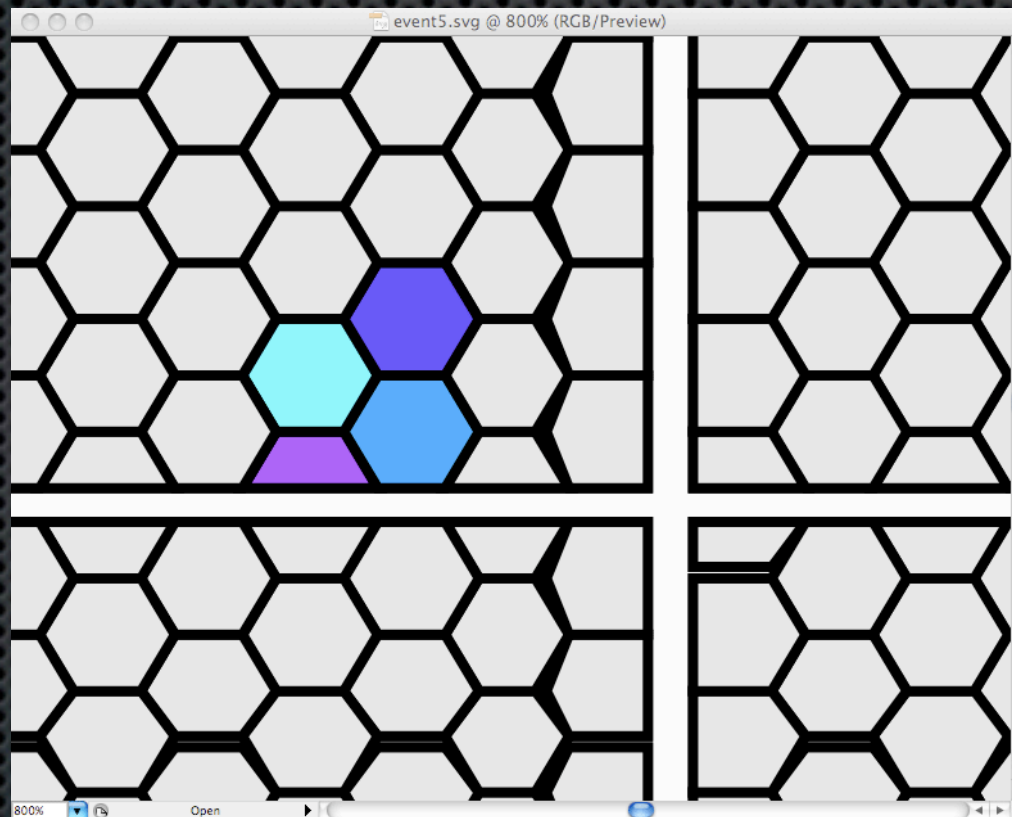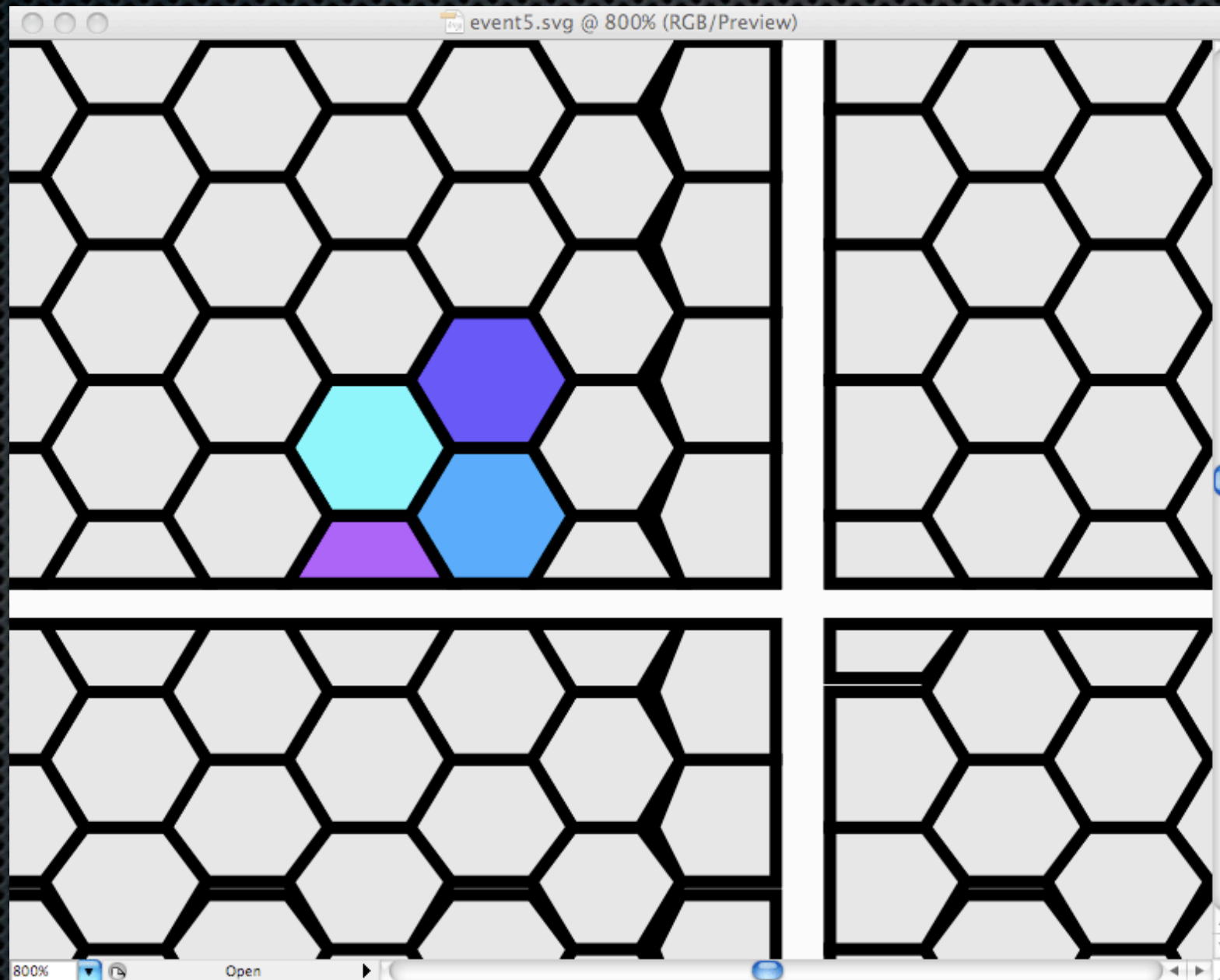

- There are six three-tuples that share same "hot" pad.
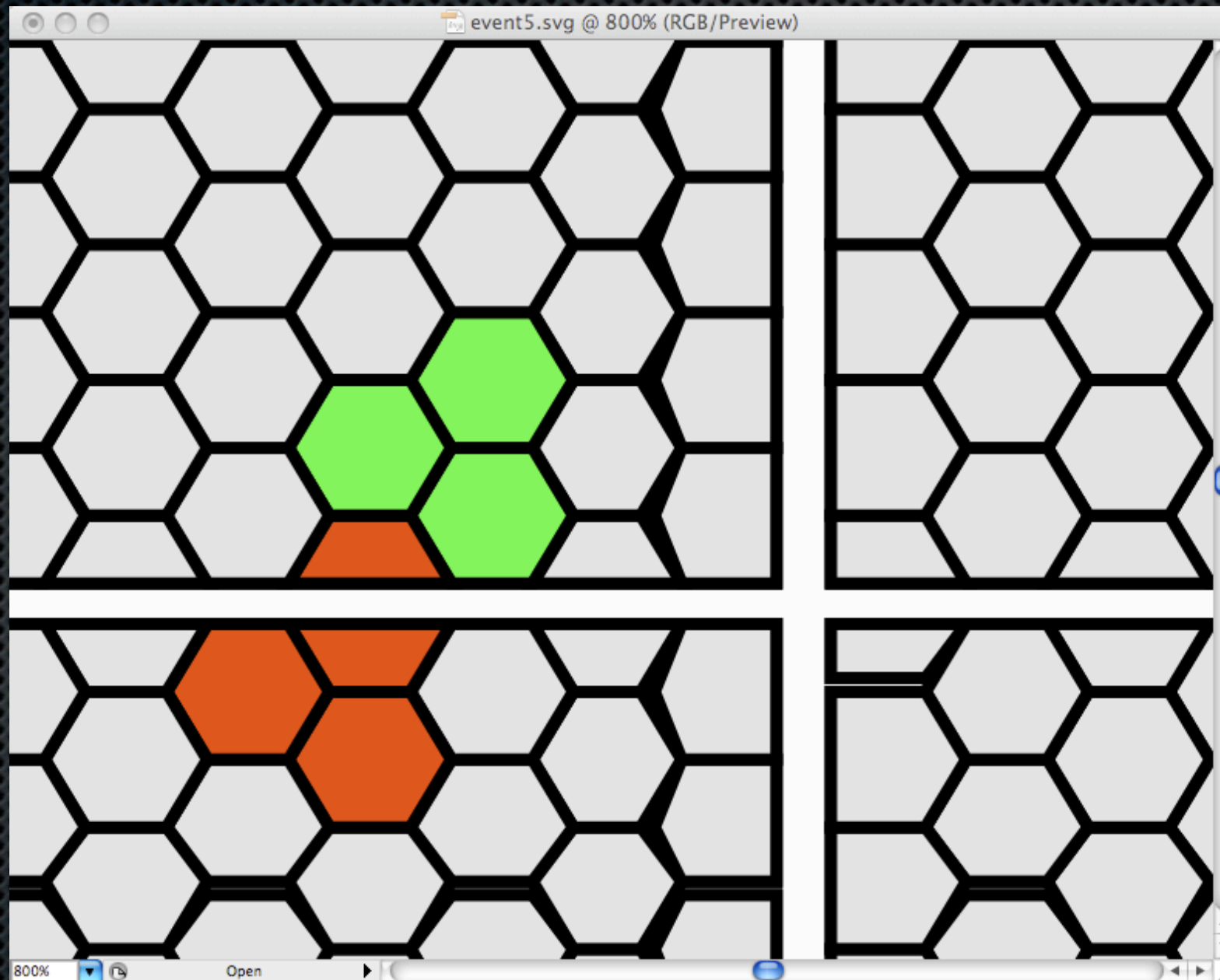
Finding spoke for given radius

Hub n' Spoke

Hub n' Spoke

Define electron Likelihood

- A single will have average number photoelectrons and a double should be roughly twice that number.

- The Likelihood is just the $\exp(\#pe-<pe>)^2$.

- The $\ln(\text{Likelihood}) = (\#pe-<pe>)^2$ for single.

- And $(\#pe-2<pe>)^2$ for double.

- Determine which one is smaller to maximize likelihood.

Simulation Data?

* Can generate many different types of data.

  * single electron, double electron, AuAu, etc.

* Using AuAu minbias it is difficult to get statistics needed.

* Does somebody know how embedding works in Hbd code?

* Can real data be used? Needs calibration?

Summary

* Currently have coded three-tuple hub, with three-tuple spoke. (Still some work to do.)

* Code is currently very complex and messy. Can this be cleaned up?

* What data should I generate to test algorithm?